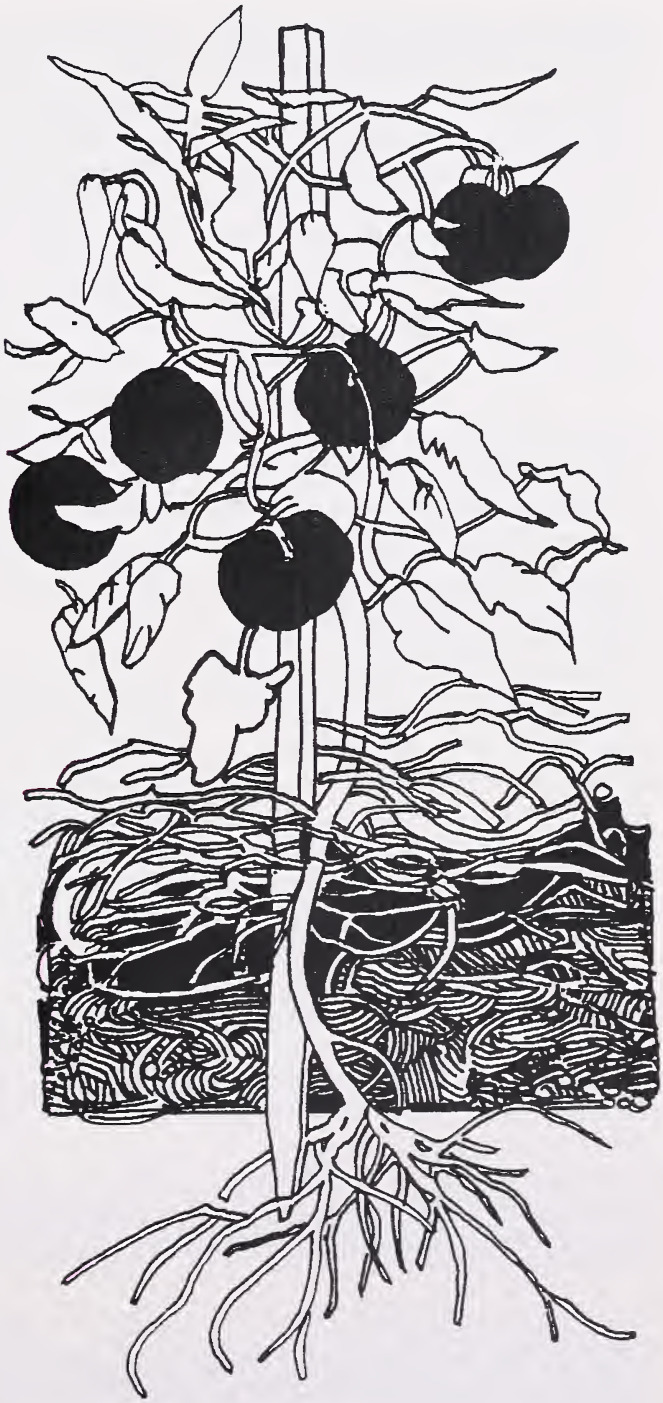
Sustainable Production of Fresh-Market Tomatoes With Organic Mulches



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Sustainable Production of Fresh-Market Tomatoes With Organic Mulches

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Trade names are used in this publication solely for the purpose of providing specific information. Mention of a trade name does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture or an endorsement by the Department over products not mentioned.

This publication reports research involving herbicides. All uses of such chemicals must be registered by appropriate State and/or Federal agencies before they can be recommended.

It is important to follow the approved label instructions when applying or disposing of any pesticide materials.

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Growing Tomatoes in a Cover Crop Mulch

The alternative production system described in this bulletin uses the winter annual legume hairy vetch both as a cover crop and a mulch in a tomato production system. As a cover, vetch serves to fix nitrogen, recycle nutrients, reduce soil erosion, and add organic matter to the soil. When converted to a mulch, vetch reduces weed emergence, lowers soil temperature during the hot summer months, reduces water loss from the soil, and acts as a slow-release fertilizer.

Recommended Cover Crop Species

The choice of cover crop species must take into consideration its winter-hardiness, its efficiency in fixing nitrogen and producing biomass, and the length of the growing season. Table 1 lists properties of winter annual legumes that have been tested in Maryland. Hairy vetch has proven to have the widest range of adaptability and consistently high rates of nitrogen fixation and biomass production. Common vetch, subterranean clover, arrowleaf clover, austrian winter pea, and berseem clover are not as winter hardy in Maryland as hairy vetch, bigflower vetch, or

Table 1.
Winter annual legumes tested in Maryland

Cover crop	Best variety	Vigor	Winter hardiness	Time of max. growth	N content (%)
Hairy vetch	——	Excel.	Excel.	May-June	4
Bigflower vetch	Woodford	Excel.	Excel.	May	3.5
Common vetch	Vantage	Good	Fair	May	3.5
Crimson clover	Chief/ Dixie	Good	Good	April	2.5
Subterranean clover	Mt. Baker	Variable	Fair	May	3
Arrowleaf clover	Yuchi	Good	Fair	June	3
Austrian winter pea	—	Good	Fair	May	3.5
Berseem clover	Bigbee	Good	Poor	June	3

crimson clover. Bigflower vetch seed is difficult to obtain. Crimson clover provides excellent biomass for mulching but does not have as high nitrogen content as hairy vetch. Hairy vetch has proven to be the best cover crop for the mid-Atlantic region and will be highlighted in this bulletin. Other cover crops may be more suitable for other areas, but the principles presented here still should apply.

Establishing the Cover Crop

The field is plowed and disked in September, and permanent beds that can be used for 2 to 3 years are formed (5 feet from center to center and 6 inches high) and seeded with the winter annual cover crop. Research at Beltsville, Maryland, identifies hairy vetch as the legume cover crop of choice for many locations. Different winter legumes and planting dates may be more suitable for other areas. Allow about 2 months to establish your cover crop before winter freeze-up.

Hairy vetch seed should be broadcast at 25 to 40 pounds per acre. Inoculation of seeds with the proper rhizobium is necessary only if this is the first time the legume is seeded in the field. Seed should be placed just below the soil surface of a firm seedbed using a forage or grass seeder. Hairy vetch emerges

Plots of hairy vetch (left) and crimson clover in late April, shortly before mowing.

within 1 week, and the seedlings grow 5 to 6 inches and establish an over-ground mat before winter. During subfreezing temperatures, plants can be expected to turn purple and become prostrate but they will resume their growth early in spring. When it is time to transplant the tomatoes to the field, the vetch plants have already attained 4 to 5 feet in length; however, because of their creeping growth habit, they lodge and form a thick stand about 2 feet high.

Between October and May, the vetch cover crop produces 3,000 to 5,000 pounds per acre of dry matter and fixes about 100 to 200 pounds of nitrogen per acre, an amount that will support the growth of the upcoming tomato crop without any supplemental commercial nitrogen. Vetch also accumulates an appreciable amount of phosphate, potassium, and micronutrients. Research has not been conducted to determine the capacity of vetch to substitute for these nutrients. Conventional fertility practices are recommended for nutrients other than nitrogen.

Converting the Cover Crop Into an Organic Mulch

Because the cover crop makes most of its growth during the month before tomato transplanting, it should be left to grow until immediately before the trans-

Before tomatoes are transplanted, a high-speed flail mower converts the cover crop into a mulch.

A close-up view of the vetch mulch reveals the abundant biomass, which accounts for its effectiveness in suppressing weeds and retaining soil moisture.

planting. There are two options to convert the cover crop into a mulch. One is chemical kill with a contact herbicide. The second is mechanical kill by mowing. Mowing reduces the use of off-farm inputs and toxic substances. A high-speed flail mower, which cuts the plants about 2 inches above bed surface, is recommended because it forms a uniform cover that controls soil erosion and inhibits weed emergence. A high-speed mower is essential because a lower speed mower such as a sickle bar becomes tangled in the vetch vines. For small areas of home gardening, the vetch plants can be cut manually and then spread to cover the bed.

A third alternative is to cultivate the hairy vetch vines into the bed with a Rototiller or similar equipment. This has the advantage of rapid decomposition of the vetch and nitrogen release. This alternative may be favored in areas with too little rainfall during the summer to permit a surface mulch to adequately degrade. However, the beneficial features of a surface mulch—erosion control, soil moisture retention, improved water infiltration, improved soil structure, and weed suppression—would be lost.

Planting the Tomato Crop

Field planting is done mechanically on a large scale and manually on a small scale. Commercial transplanters of varying sizes and capacities are available that are designed to

operate in thick organic mulches. These planters can be equipped with coulters that cut and loosen a narrow band in the bed with minimum interruption to the mulch layer. However, coulters can tangle in the vetch vines if not set properly. Transplanters also are equipped with spades to open a hole, deliver a dose of liquid fertilizer, set the plant at the right depth, and press the soil firmly around it. It is important that the transplant ball be set firmly in the soil below the mulch rather than within the mulch layer itself. Recommended spacing between plants within the row is 16 to 20 inches, depending on plant vigor and variety.

A hand planter can be used for planting tomatoes manually on a small scale. Insert the planter into the soil to a depth of 4 or 5 inches and move it back and forth once to open a wedge-shaped hole 4 inches long by 2 inches wide. Insert the transplant into the hole, press soil around it, then return the mulch to its position around the transplant to cover the interrupted area. In either case, avoid walking on the beds to prevent soil compaction and maintain mulch uniformity so that the same bed may be used for two or three seasons without reshaping.

Managing the Tomato Crop

Once the tomatoes are planted, management should focus primarily on major practices that result in high yield of high-quality product: providing

A fresh-market tomato field with different types of mulches.

Hairy vetch effectively controls weeds while providing nutrients to tomato plants.

optimum water and nutrients and controlling weeds and pests throughout the growing season.

Water management is critical for producing high-quality tomatoes. Short drought spells may delay maturity, reduce yield, and lower the quality. On the other hand, excessive water, especially in soils of poor drainage, reduces plant growth and increases the incidence of diseases. Trickle irrigation can conserve water by applying small amounts directly to the plant root zone. You can apply fertilizer through the trickle system as often as needed. It is particularly effective when used with mulches and also effective in reducing weed growth in the areas of the field that remain dry.

Trickle irrigation lines are installed on top of the vetch mulch and 3 to 4 inches from the tomato row and fixed in place with U-shaped wires. The trickle system must be installed immediately after planting so that transplanted plants do not face moisture stress conditions.

Application of fertilizers through the trickle system is most efficient because only small amounts are delivered at a time. Best results are achieved when fertilizer is applied weekly or biweekly. When tomatoes are grown in a vetch mulch, the demand for commercial fertilizers in general, and for nitrogen in particular, becomes less. Research has demonstrated that a good stand of vetch, when mowed and converted into a mulch, provides sufficient nitrogen for the tomato crop that follows. Therefore, only phosphorus, potassium, and micronutrients need to be applied through the irrigation system.

Staking and tying up the plants is highly recommended for fresh-market tomatoes. This operation

can be initiated 2 to 3 weeks after planting and continues as the plants grow bigger.

Hairy vetch will not regrow if mowed at flowering time. However, the optimum time for transplanting tomatoes may precede flowering by 2 to 3 weeks. If mowed at this time, sufficient regrowth of hairy vetch may occur to overgrow tomato plants about 3 to 4 weeks after transplanting.

In addition, the vetch mulch will suppress weed emergence during the first month after mowing. However, as the vetch vines decompose, weed seedlings will eventually emerge through the mulch and require control with postemergence herbicides.

Therefore, an application of 0.5 pounds active ingredient per acre of metribuzin will probably be needed approximately 3 to 4 weeks after transplanting to control vetch regrowth and/or emerging weeds, whichever comes first. It is important to make this application promptly when weed seedlings are first sighted or vetch regrowth begins threatening tomato plants. An additional postemergence application of a registered grass herbicide may be necessary to control late-emerging grass weeds. Consult product labels for specific information.

Disease and insect control probably will require fungicides and insecticides. Use of an integrated pest management

Tomatoes grown in bare soil, wheat staw, and hairy vetch. Hairy vetch mulch produced the highest growth.

program can reduce the number of applications required. Use of proper rotations is essential for preventing the build-up of pest populations. Consult your local extension office for further information.

After harvest, the tomato plants are mowed with a high-speed flail mower in the same way the vetch cover crop was mowed earlier, and the plant residues are left in the field. During mowing, every effort should be made to keep the beds intact so that they can be used again without the need for plowing and forming new beds. This will also reduce soil compaction and allow seeding the new cover crop immediately after the tomato crop.

Conclusion

This no-tillage system with a winter-annual cover crop has consistently yielded greater total fruit than traditional bare soil or black polyethylene mulch treatments (Table 2). It eliminates the use of preemergence herbicides, nitrogen fertilizer, and polyethylene mulches, resulting in economic savings and environmental conservation. By reducing tillage and adding a cover crop, it builds soil quality and contributes to the sustainability of production for future generations.

Table 2.
Yields of fresh-market tomatoes grown in bare soil, black polyethylene, and hairy vetch mulches.

	Yield (tons/hectare)			
Mulch	**1991**	**1992**	**1993**	**Average of 3 years**
Bare soil	53	36	74	54
Black polyethylene	107	44	82	78
Hairy vetch	129	86	87	101

References

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Sustainability in Agriculture

In its simplest sense, sustainable agriculture is profitable crop production that builds soil resources and prevents environmental contamination. Sustainability involves social, economic, and ecological relationships at local, national, and global levels. It encompasses the interrelatedness of all parts of the farming system, including farmers and their families. Sustainable agriculture underscores the importance of biological balances and the need to minimize use of material and practices that disrupt these relationships.

Many sustainable practices are not new but rather rediscoveries of ancient ways to grow food. Some of the agricultural production areas of the old world, including the delta of the Nile of ancient Egypt, the delta of the Euphrates and Tigris rivers of Mesopotamia, and the coastal plains of ancient Greece and Rome, are as productive today as they were several thousand years ago. Despite continuous intensive land use, sustainability has continued to the present day, unequivocal evidence that sustainability can be preserved indefinitely if proper farming practices are adopted.

The goal of sustainability is to build and maintain the soil at a high level of fertility. Farmers in the ancient farming communities realized this fact long before the chemical era dominated what is now known as modern agriculture. Amendments that were available to farmers for improving soil fertility were limited to legume cover crops and animal manures, both renewable farm products. Farmers in ancient Egypt, Greece, and Rome used such legumes as faba beans *(Vicia faba),* vetch *(Vicia species),* and lupins *(Lupinus* species) as important cover crops in their grain production rotations. These legumiuous cover crops provided seasonal animal feed and were plowed under to enrich the soil with the nutrients and organic matter.

Settlers in the New World seldom used legume cover crops because they selected fertile land for farming. However, in less than two centuries of poor management, many farms have lost fertility. Today, over 40 percent of the cultivable land in the United States is losing topsoil at annual rates that exceed 5 tons per acre, rates that are considered unsustainable. It is only by returning to sustainable agricultural practices that we will reverse the trend toward losing topsoil and declining fertility.

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